American-Eurasian J. Agric. & Environ. Sci., 4 (3): 306-310, 2008
ISSN 1818-6769

Change of Grain Protein Content and Correlations with Other Characteristics under Planting Pattern and Starter N Fertilizer of Mungbean (*Vigna radiata* L. Wilczek)

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Abstract: A field study was carried out to evaluate the change of grain protein content and correlations with other characteristics of Mungbean (*Vigna radiata* L. Wilczek) under planting pattern; 1- Broadcasting (random pattern), 2- Strip pattern (50 cm inter row spacing and 10 cm intra row spacing), 3- Square pattern (hill pattern, 50 cm inter row spacing and 50 cm intra row spacing) as main plots and starter N fertilizer at rate of 0, 25 and 50 kg ha^{-1} as sub plots. The results indicated that maximum grain protein yield (348.48 kg ha^{-1}) associated to square pattern and application of starter N fertilizer at 50 kg ha^{-1} (24.86%) significantly had greater grain protein percentage as compared to the control (application of 0 kg ha^{-1} starter N fertilizer) (23.7%). Data showed that application of 25 and 50 kg ha^{-1} starter N fertilizer had better effect on grain protein yield of 273 and 274 kg ha^{-1}, respectively compared to application of 0 kg ha^{-1} starter N fertilizer (223.7 kg ha^{-1}). Strong positively correlations were observed between grain protein yield and grain yield, TDM (Biological yield), number of pod per plant and 1000- grain weight.

Key words: Mungbean (*Vigna radiata* L. Wilczek) · Planting pattern · Starter N fertilizer · Protein content · Correlations

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) commonly known as green gram is one of the most important legumes in many Asian countries including China, India, Pakistan. This is mainly because Mungbean can be grown in a wide range of environments. It is a major source of high quality protein. The grain of Mungbean contains around 24- 26% protein [1]. Various factors responsible for low yield of Legumes at farmer's field include unawareness of farmers about optimum date of sowing, improper planting patterns, insufficient weed control, pest management practices and imbalanced use of fertilizers. Among these factors, improper planting pattern and imbalanced use of fertilizers are great importance. Planting pattern influences the radiation interception and utilization of moisture from soil. Broadcasting is still the principal method of Mungbean raising which is one of the major yield limiting factors [2,3]. It is well documented that sowing in appropriate inter row and intra row spacing is the best strategy for the highest production. Khan *et al.* [4] found that planting geometry had significant effect on yield and yield components of Mungbean. Rehman [5] observed that planting pattern influences radiation interception and utilization of moisture from the soil. Asghar *et al.* [6] maintained that grain yield and yield components were affected by different planting patterns and broadcasting (random pattern) produced minimum grain yield.

Rate of nitrogen fixation is trivial at beginning of growing season, because in this period don't complete nodulation and don't transfer sufficient carbohydrate to the roots. In this period, bacteries don't give any nitrogen to the seedlings. Therefore, seedlings need small starter doses of fertilizer N by mineral or chemical nitrogen [7-10]. Singh *et al.* [11] maintained that grain yield and protein content of Mungbean was increased by the application of 20 kg N ha^{-1}. They further concluded that yield components also significantly affected by N fertilizer. Patra and Bhattacharyya [12] observed that the highest grain yield and yield components were obtained by applied urea (25 kg ha^{-1}). Ashraf [13] found that number of pods per plant, No. of seeds per pod, 1000- seed weight and correlations between the characters were significantly affected by the application of varying level of N from 20 to 50 kg ha^{-1}. Mahboob and Asghar [14] found that various yield components were significantly affected by the application of 50 kg N ha^{-1}.

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MATERIALS AND METHODS

The present experiment was conducted during spring and summer of 2006- 2007 at the Agronomic Research Area, Faculty of Agriculture, Lorestan University. Randomized complete block design (RCBD) in a split plot arrangement with four replications was used to carry out the experiment. Randomizing the planting pattern; 1- Broadcasting (random pattern), 2- Strip pattern (50 cm inter row spacing and 10 cm intra row spacing), 3- Square pattern (hill pattern, 50 cm inter row spacing and 50 cm intra row spacing) as main plots and starter N fertilizer at range of 0, 25 and 50 kg ha^{-1} as sub plots. In square pattern (hill pattern) 6- 8 seeds was planted in a hill and finally they arrived to 5 shrub per hill and 20 shrub per m^2 by thinning at the 2 weeks after planting. The whole quantity of fertilizers was side dressed just after sowing (by attention to the treatments). The source of N fertilizer was uric- acid with 46% net nitrogen.

Grain samples were analyzed for total N using Kjeldahl digestion. For this means powdered grains (100 grams of each treatment) were combined with chemical solvents such as Sulfuric Acid, Potassium Sulfate and Copper sulfate as Catalyzors and Sodium Hydrate and Boric Acid as solvents. Finally, amount of nitrogen was measured and grain protein yield was accounted with follow [11,13,15,16].

Grain Protein yield (kg ha^{-1}) = Grain protein percentage (%) × Grain yield (kg ha^{-1})

All other agronomic practices were kept uniform for all the treatments and observations regarding various agronomic characters were recorded by following the standard procedures. Data collected and analyzed statistically using the Analysis of Variance Technique (ANOVA) by MSTAT-C software (version 1.42, Michigan State University, USA.) and Duncan's new multiple rang test was applied to compare the means of treatments [17].

RESULTS AND DISCUSSIONS

Grain Yield and Yield Components: Grain yield was significantly affected by planting pattern and starter N fertilizer, while their interactions had no significant effect on grain yield (Table 1 and 2). Maximum grain yield of 1452 kg ha^{-1} was recorded for square pattern (hill pattern) and was followed by strip pattern (906.7 kg ha^{-1}), while broadcasting (random pattern) produced only 801.3 kg ha^{-1}. Data showed that the highest grain yield related to the application of 50 kg ha^{-1} starter N fertilizer, which were significantly different from one another. The application of 50 kg ha^{-1} starter N fertilizer gave maximum grain yield (1123 kg ha^{-1}) that were statistically different from the application of 0 kg ha^{-1} starter N fertilizer

Table 1: Results of analysis of variance (MS) for various characters

Sources of variations (S.O.V)	Grain protein percentage	Grain protein yield	Grain yield	Biological yield	No. pods plant^{-1}	No. grains pod^{-1}	1000- grain weight
Planting pattern (Factor A)	4.167^{ns}	78747.521**	1097468.07**	7095422.194**	308.961*	1.329^{ns}	250.074^{ns}
Error 1	7.029	4669.92	59484.683	185205.056	27.568	0.37	143.459
Starter N fertilizer (Factor B)	11.731**	7450.978**	55264.224*	1335250.75**	39.516**	0.241^{ns}	25.013^{ns}
A × B	0.922^{ns}	1225.483^{ns}	8094.446^{ns}	78751.028^{ns}	3.231^{ns}	0.51^{ns}	31.654^{ns}
Error 2	1.448	742.532	16447.273	175036.435	4.715	0.265	20.509

$^{**}P \leq 0.01$ $^{*}P \leq 0.05$ ^{ns}Non-Significant

Table 2: The effects of planting patterns and starter N fertilizers on grain protein percentage, grain protein yield, grain yield and yield components of Mungbean

Treatments	Grain protein percentage (%)	Grain protein yield (kg ha^{-1})	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})	1000-grain weight (g)	No. pods plant^{-1}	No. grains pod^{-1}
Planting patterns							
1- Broadcasting (random pattern)	23.7 a*	189.90 b	801.3 b	2840.0 b	45.0 a	12.44 b	9.90 a
2- Strip pattern (50 × 10)	23.97 a	217.30 ab	906.7 b	3451.0 b	47.8 a	15.64 b	10.00 a
3- Square pattern (hill pattern)	24.00 a	348.48 a	1452.0 a	4589.0 a	48.0 a	23.81 a	10.30 a
Starter N fertilizers							
1- Application of 0 kg ha^{-1} starter N fertilizer	23.13 b	223.70 b	968.3 b	3343.0 b	48.0 a	15.42 b	9.80 a
2- Application of 25 kg ha^{-1} starter N fertilizer	25.41 a	273.00 a	1069.0 ab	3472.0 ab	51.0 a	16.92 ab	10.17 a
3- Application of 50 kg ha^{-1} starter N fertilizer	24.86 ab	274.00 a	1123.0 a	4065.0 a	48.5 a	19.56 a	10.11 a

* Means not sharing at letter in common in a column differ significantly ($P \leq 0.05$)

(968.3 kg ha^{-1}), but was statistically at par with application of 25 kg ha^{-1} starter N fertilizer (1069 kg ha^{-1}) (Table 1 and 2). It is conceivable that the fertilizer of N stimulated plant establishment and early growth and may have improved nodulation through positive effect on seedling roots. These results are in conformity with those of reported by Ashraf [13] and Tien *et al.* [10], who observed that rhizobial inoculation had little effect on yield and yield components of Mungbean and plants responded to small starter doses of fertilizer N.

Between the yield components just number of pods per plant was significantly affected by planting pattern at 0.05 levels of probability and starter N fertilizer at 0.01 level of probability. Square pattern (hill pattern) produced maximum number of pods per plant (23.81) (Table 1 and 2). Also, the treatment of application of 50 kg ha^{-1} starter N fertilizer gave maximum number of pods per plant (19.56), which were statistically different from the application of 0 kg ha^{-1}starter N fertilizer (15.42) and was statistically equal to application of 25 kg ha^{-1} starter N fertilizer with production of 16.92 number of pods per plant. These means that different planting patterns and starter N fertilizers affected grain yield by increasing the number of pods per plant. These results are supported by Ashraf [13], who reported that number of pods per plant was significantly affected by application of N from 20 to 50 kg ha^{-1}.

Biological Yield (Total Dry Matter): Biological yield (total dry matter) was significantly affected by different planting pattern and different levels of starter N fertilizer (at $p \leq 0.01$), while their interactions had no significant effect on biological yield (Table 1 and 2). Maximum biological yield (total dry matter) was recorded by square pattern (hill pattern) and the application of 50 kg ha^{-1} starter N fertilizer (4589 and 4065 kgha^{-1}, respectively), that were statistically different from one another (Table 2). These results are supported to those of Mahboob and Asghar [6] and Ashraf [13], who found that biological yield and yield components significantly affected by application of N fertilizer.

Protein Content: The results showed that higher grain protein yield related to the square pattern (hill pattern) (348.48 kg ha^{-1}) that had many difference with broadcasting (random pattern) with 189.9 kg ha^{-1} grain protein yield (Table 1 and 2). These results confirmed the findings of Rehman [5] and Khan *et al.* [4], who observed that planting pattern influences radiation interception and utilization of moisture from the soil and significantly affected yield, yield components and quality of Mungbean. Different planting patterns had no effect on protein percentage and increased grain protein yield by increasing the grain yield (Table 1 and 2).

Different levels of starter N fertilizer had significant effects on grain protein percentage and grain protein yield (Table 1). The means table revealed that application of 25 and 50 kg ha^{-1} starter N fertilizer with protein percentage of 25.41 and 24.86%, respectively had better effects in comparison to the control (application of 0 kg ha^{-1} starter N fertilizer) with 23.13% protein percentage. Data also showed that application of 25 and 50 kg ha^{-1} starter N fertilizer significantly had better effects on grain protein yield with 273 and 274 kg ha^{-1}, respectively in compared to the control with 223.7 kg ha^{-1} grain protein yield (Table 2). Analysis of Variance Technique (ANOVA) and Duncan's New Multiple Rang Test showed that interactions between planting patterns and different levels of starter N fertilizers was found to be non- significant (Table 1 and 2). These results are in support whit those of Singh *et al.* [11] and Ashraf [13] in case of Mungbean, who reported that grain yield and grain protein content of Mungbean was increased by the application of 20- 50 kg N ha^{-1}.

Correlations Between Different Characteristics with Percentage and Grain Protein Yield: By consider the correlations table (Table 3) observed that there was strong positively correlation between grain yield and grain protein yield ($P \leq 0.01$). Also, there was positively correlation between grain protein percentage and grain protein yield significant at 0.05 level of probability (Table 3). These results showed that grain protein yield was increased by increasing the grain protein percentage under application of small starter N fertilizer. These results are similar to the findings of Singh *et al.* [11], Patra and Bhuttacharyya [12], Ashraf [13] and Mahboob and Asghar [14].

There was strong positively correlation between biological yield and grain protein yield (P=0.01). This means that application of starter N fertilizer and suitable planting pattern could affect grain protein yield by increasing the whole dry matter production

Table 3: Correlations between various characters

Characters	Grain protein percentage	Grain protein yield	Grain yield	Biological yield	No. pods plant^{-1}	No. grains pod^{-1}	1000- grain weight
Grain protein percentage	1						
Grain protein yield	0.46^{*}	1					
Grain yield	0.29^{ns}	0.982^{**}	1				
Biological yield	0.149^{ns}	0.832^{**}	0.862^{**}	1			
NO. pods plant^{-1}	0.322^{ns}	0.91^{**}	0.908^{**}	0.912^{**}	1		
NO. grains pod^{-1}	0.107^{ns}	0.348^{ns}	0.358^{ns}	0.402^{*}	0.379^{ns}	1	
1000- grain weight	0.47^{*}	0.647^{**}	0.603^{**}	0.472^{*}	0.499^{**}	0.048^{ns}	1

** $P \le 0.01$ * $P \le 0.05$ ^{ns} Non-Significant

(biological yield). Also, there were strong positively correlations between grain protein yield with number of pods per plant and 1000-grain weight ($P \le 0.01$). These correlations showed that increasing the one of above could cause grain protein yield. These results are in line with findings of Singh *et al.* [11] and Ashraf [13].

CONCLUSION

The present study concluded that maximum production of Mungbean (grain yield, yield components and grain protein yield) was recorded for square pattern (hill pattern) and was followed by strip pattern, while broadcasting (random pattern) produced minimum production. Therefore, sowing in appropriate planting pattern can caused Mungbean production and broadcasting (random pattern) is one of the major yield limiting factors of Mungbean. Also, results of these experiment showed that application of small starter N fertilizer (50 and 25 kg ha^{-1}, respectively) had better effect on grain yield, yield components and grain protein yield compared to the control (application of 0 kg ha^{-1} starter N fertilizer). Therefore, we can increase yield and grain protein content of Mungbean by application of small starter N fertilizer.

ACKNOWLEDGEMENTS

Financial supports from the Lorestan University, Iran is gratefully acknowledgement.

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